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FEED ADDITIVES, MINERALS, AND VITAMINS FOR DAIRY CATTLE

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Feed additives, minerals, and vitamins are now included in the rations fed our domestic animals. Dairy nutritionists, feed manufacturers and mixers, and dairymen are concerned about the needs of the dairy cow for these feed supplements.

The dairy cow, unlike some other classes of livestock, still subsists largely on feeds similar to those she consumed in her natural habitat -- pasture and forages. On the other hand, swine and chickens are now reared under more artificial conditions and no longer subsist on the feeds of their natural habitat. For this reason, supplements containing minerals, vitamins, and other required nutrients are added to the diets of swine and chickens.

The digestive processes of the dairy cow enable her to convert the pasture and forage she eats into the nutrients she needs for maintenance and milk production. The rumen, which holds about 40 gallons of wet mushy material, acts as a fermentation vat. Bacteria in the rumen break down (ferment) feed nutrients into simple compounds which are resynthesized into new nutrients or compounds. For instance, carbohydrates are broken down by bacterial fermentation into organic acids such as propionic, acetic, and butyric, which in turn serve as a source of energy. As a matter of fact, the organic acids produced in the rumen are a major source of energy for the dairy cow. Likewise, protein is broken down into amino acids and into other simple nitrogen compounds such as ammonia, which may be resynthesized by the bacteria into protein. These rumen bacteria then are digested and form the source of protein for the dairy cow.

Similarly, many vitamins, such as vitamin B_{12}, riboflavin, and other B-vitamins, are synthesized by bacterial fermentation in the rumen. These vitamins do not need to be added to the cow's ration.

Despite the fact that the dairy cow is able to convert pasture and forage into the nutrients she needs, it is sometimes good practice to supplement her ration. Through breeding and selection, the milk-production level of the dairy cow has been increased tremendously. To produce more milk, she requires more energy and sometimes more protein, minerals, and vitamins.

To provide more energy in the ration, the present trend is to feed increasing amounts of concentrates and decreasing amounts of forage. If this trend continues, the cow will be in the same class as swine and chickens in regard to need for minerals, vitamins, and other feed additives.

MINERALS

The dairy cow consumes large amounts of forage, which contains most of the mineral elements she needs. For instance, forage furnishes more than enough calcium for maintenence and milk production--and milk contains large amounts of calcium.

If the grain mixture contains high protein concentrates, it usually contains enough phosphorus. But if the grain mixture contains only cereal grains and other feeds low in phosphorus, some supplemental supply of phosphorus is generally required. This is usually added to the concentrate mixture in the form of bonemeal, di-calcium phosphate, or deflorinated phosphate.

A mineral requirement often overlooked is common salt, which furnishes the very necessary sodium and chlorine. Of the two, sodium is more important.

Research has shown that feed grown in certain areas is deficient in particular nutrients called trace minerals. To overcome this difficulty, most commercial feed mixtures contain sources of iron, copper, cobalt, and iodine. These trace minerals can also be fed in a trace-mineralized salt mixture.

The dairy cow does not appear to need highly complex, costly mineral mixtures containing elements other than those mentioned.

VITAMINS

As indicated earlier, many vitamins are synthesized in the rumen of the dairy cows. Insofar as we know, the dairy cow requires only three vitamins from the feed supply: vitamins A, D, and E.

Vitamin A deficiency does occur, although infrequently, in farm dairy herds where the quality of forage is poor or where an insufficient quantity of forage is fed young animals. Dehydrated alfalfa, pasture, grass silage, and good-quality hay are important sources of carotene (pro-vitamin A).

Since good-quality forage furnishes a sufficient supply of carotene, a vitamin A supplement is not generally recommended for dairy cattle. The amount of hay necessary to meet twice the minimal requirements of carotene for normal reproduction is shown in table 1. Hay fed at the farm will usually be grade No. 2.

Vitamin A is generally added to calf starters and milk replacers because calves do not consume large quantities of forage in their early period of growth and may have only a small store of vitamin A at birth.

Vitamin D is also contained in the forages which dairy cattle consume. Under average conditions, vitamin D is not added to the rations of mature dairy cattle. But vitamin D is generally added to calf starters and milk replacers.

Vitamin E (tocopherol) is usually present in concentrates and forages in sufficient quantity for mature dairy cattle. Vitamin E is sometimes added to milk replacers.

FEED ADDITIVES

Urea. Urea can be fed to dairy cattle as a protein substitute. Dairy cattle are able to use urea because bacteria in the paunch convert the urea into amino acids and protein. Protein is stored in the bacteria and becomes available to the animal as the bacteria are digested.

For bacteria to produce protein from urea, a readily available carbohydrate (starch or sugar) must be present in the paunch. Urea is not used efficiently when fed with a ration such as timothy hay or straw that is low in carbohydrates and protein. However, if starch is added, urea will be efficiently used.

High-carbohydrate feeds, such as cereal grains or molasses, generally are used with urea. Starch from grains is more effective than sugar from molasses.

Natural urea is excreted by animals; it is poisonous. Synthetic urea can be poisonous when too large quantities are consumed. Deaths in cattle have resulted from feeding improperly mixed concentrates and urea.

Urea in its crystalline form resembles salt or granular sugar. One pound of urea supplies the amount of protein in 6.4 pounds of 41-percent soybean meal or cottonseed meal.

Urea is not palatable to cows and is not as readily consumed as oil meals. It should not be mixed with cheap concentrate feeds, high in fiber, merely to meet the protein needs of producing cows. Such a grain mixture would be poor in quality, low in energy, and unsatisfactory for milking cows.

Urea is not effective when added to high-protein grain rations for milk production. It should not be added to grain rations already containing 14 to 18 percent of protein. When added to homegrown-grain rations containing 10 percent of protein or less, urea is effective.

Where high-protein forages, such as good-quality alfalfa hay, early-cut grass-legume mixtures, or grass silage, are fed along with homegrown grains, addition of protein concentrate or urea to the grain mixture will not increase milk production.

If 1 pound of urea and 6 pounds of carbohydrate concentrate cost less than 7 pounds of protein concentrate, it would be economical to feed urea. Mix it with homegrown cereal grains or a high-energy grain mixture. For each 1 percent of urea added to the grain mixture, the protein content of the mixture is increased by 2.6 percent.

If the grain mixture contains 9 percent of protein, adding 2 percent of urea will increase the protein value of the mixture to about 14.2 percent. Urea should not be added to the grain mixture in an amount greater than 3 percent nor to increase the protein level above 16 percent.

Antibiotics. Since 1950, we have heard considerable about the use of antibiotics in the diets and rations of domestic animals. They are widely used in the diets of chickens and swine, and in beef cattle fattening rations. Some thought has been given to their use in dairy-cattle feeds. Antibiotics are now added to commercial calf milk replacers and starters. Feeding an antibiotic for 10 to 12 weeks increases rate of gain and decreases losses due to scours. Quite likely under practical conditions, the latter is of greater importance since the increase in rate of growth disappears during the subsequent growth period.

Many advertisements in farm papers have recommended including Aureomycin[1/] in the rations of mature dairy cattle to prevent foot rot and other low-grade infections and to increase milk production. Data supporting these recommendations are not sufficiently positive to warrant inclusion of Aureomycin in the rations of mature dairy cattle.

Hormones. Hormones have been fed from time to time to various classes of livestock. These hormones are normally secreted by the various internal glands in the body and control various physiological activities. If we knew exactly the amount and rate of secretion of these various hormones in the body of a cow, we might make a good cow out of a poor cow, or even a dairy cow out of a beef cow merely by feeding or injecting these hormones in their proper sequence and amounts. However, at present we do not have information on the correct balance among the many hormones secreted in the animal body. For this reason we are not able to make intelligent use of the one or more hormones commercially available. When only one hormone is injected or fed, it is probable that the animal body will in time develop a defense or inactivation mechanism against the particular hormone. Therefore, it seems probable that the effect of a single hormone will not last. Until we have a better understanding of the complete balance and rate of secretion of the various hormones, it does not seem likely that they will be used over extended periods to increase milk production.

The hormone, thyroprotein, has been used extensively in experiments conducted at Beltsville showing that thyroprotein does very materially increase the level of milk production for 3 to 4 months. However, total milk production for the lactation is not increased where intake of energy is not increased. Except under very specific conditions, where the dairy farmer desires to increase milk production during the base period, thyroprotein feeding is not recommended.

1/ Mention of a trade name does not imply endorsement by the U. S. Department of Agriculture over others not mentioned.

Another hormone, stilbestrol, has been used in the fattening rations of beef cattle. It promotes increased feed efficiency and rate of gain. To date, there is no clear-cut evidence to recommend its use in rations fed to lactating dairy cows. Experimental work at Beltsville with lactating dairy cows did not demonstrate that feeding stilbestrol increased milk production, whereas similar work at Kansas did show some slight increase.

Organic acids for ketosis. Sodium propionate is another feed additive that has been recommended for dairy cattle to prevent ketosis, or acetonemia, a metabolic disease that occurs usually 1 to 3 weeks after calving. In ketosis, there is a marked loss of appetite and lowered milk production. The veterinarian generally treats the condition by injecting calcium gluconate or cortisone or a combination of the two. Research has shown that feeding sodium propionate is effective in preventing this disorder. However, there has been a problem of palatability of the feed in which the propionate is mixed.

Later studies have shown that the addition of both calcium and sodium lactate is effective in preventing ketosis and is more palatable when mixed into the grain ration. These lactate salts are fed for 7 to 8 days as 6 to 10 percent of the concentrate mixture. Despite the evidence for the beneficial effects of both calcium and sodium lactate for preventing ketosis, neither is widely sold in commercially mixed feeds. Some mixtures were tried on a commercial basis, but the demand was not sufficient to warrant their continuation.

Vitamin D for milk fever. Another metabolic disorder, milk fever, can be largely prevented by adding fairly large amounts of vitamin D to the ration. Milk fever occurs 1 to 3 days after calving and is accompanied by low blood calcium and a partial paralysis of the animal. The veterinarian treats the disorder by injecting calcium salts or inflating the udder. But research has shown that milk fever can largely be prevented by feeding from 5 to 30 million units per day of vitamin D for 3 to 7 days before and 1 day after calving. Vitamin D in the form of irradiated yeast is available in some areas in commercially mixed feeds and is used in herds susceptible to milk fever.

Bacterial cultures. From time to time additives such as bacterial cultures, organic acids, and alcohol to improve rumen function are proposed. None of these has been shown to be of any special benefit.

Sprouted grains. Some years ago, an attempt was made to introduce the "Spangenberg process" of growing sprouted grains in cabinets as a source of nutrients for livestock. The grains - corn, barley, oats, etc. - are sprouted in trays in a cabinet in a hydroponic or nutrient solution. After 8 to 10 days of growth, the trays contain a mass of green material and roots. For instance, 1 pound of oats will produce 4 or 5 pounds of green feed material. A process being offered for sale which is similar to, if not identical with, the "Spangenberg process" has come to the attention of the Dairy Cattle Research Branch during the past few years. The "Spangenberg process" was investigated quite extensively in England between 1925 and 1935. The results reported for controlled experiments were not advantageous for the process. Some recent results from the California and Michigan Agricultural Experiment Stations confirm the early work conducted with sprouted grains. Some investigators

reported a loss of as much as 25 percent of dry matter as a result of the sprouting process. This loss in dry matter would mean a corresponding loss in energy value of the feed. Some analyses showed a gain in percentage of protein but it is not clear from the data whether there was an actual gain in protein due to synthesis or whether the gain was due to the loss of dry matter.

Contrary to the claims for the "Spangenberg process", the feeding of sprouted grains did not increase the digestive processes of the animals. Also, there was no improvement in the reproductive processes or general health of the animals. If a farmer has poor-quality forage, there are other methods of supplementing the ration economically - for instance, by the use of dehydrated alfalfa. Since the feeding of sprouted grains was not recommended as a feeding practice in England or the United States when it was introduced in the 1930's, it is unlikely that the process has very much value today for the economical feeding of livestock.

SUMMARY

The needs of the dairy cow for minerals, vitamins and feed additives are relatively simple because the dairy cow still subsists largely on natural feed sources, that is, forages, which supply many of the vitamins and minerals necessary to health, reproduction, and lactation.

The dairy cow is unique in that she has a rumen containing large numbers of bacteria which rebuild feed nutrients and synthesize many of the vitamins.

The only minerals that generally need to be added to the rations of dairy cattle are phosphorus and common salt. In some deficient areas, iodine, copper, cobalt, and iron are needed.

The only three vitamins that we know the dairy cow requires in the feed supply are vitamins A, D, and E. These are furnished in ample supply by good-quality forages fed the mature animal. Vitamins A and D are usually added to calf starters and milk replacers for growing calves. Vitamin E is sometimes added also.

Urea is sometimes used as a protein substitute under certain conditions. One antibiotic, Aureomycin, is used in calf starters and is effective in promoting increased rate of growth and in decreasing the amount of scours. Its addition to the ration of mature dairy cows is not recommended. The use of sodium propionate or a combination of calcium and sodium lactate salts are moderately effective in preventing ketosis in dairy cattle. The addition of vitamin D is also effective in the prevention of milk fever. The feeding of thyroprotein, except under certain specific conditions, is not justified. The evidence at present does not warrant the use of stilbestrol. The addition of sprouted grains or various rumen bacterial factors is not justified.

Table 1. Hay Needed by Dairy Cows to Meet Double the Minimum Requirement (120 μg/lb) for Normal Reproduction

Grade of hay	Carotene content	Quantity to feeds: 800-lb. animal	1000-lb. animal	1200-lb. animal	1400-lb. animal
	μg/gm	Pounds	Pounds	Pounds	Pounds
No. 3	2	106	141	159	185
	4	53	70	80	97
	6	35	44	53	62
No. 2	12	17	22	26	31
	16	13	17	20	24
	20	11	14	16	19
No. 1	24	9	11	13	16
	30	7	9	11	12
	50	4	5	6	7